

Track and Field: Running events

If you asked a teenager what his/her favorite sport is the response would probably not be track and field. Then why start a study of sports with the track running events? Simple answer: because virtually all sports involve running and an understanding of the issues in foot races can illuminate many other topics. Also, while not many students will have played a large number of sports, all of them will likely have participated in running races. So what are the salient questions about races that we can explore? A partial list would include:

- How fast is a runner going?
- Do long distance runners go as fast as short distance runners?
- Why do some people run sprints and some distance but rarely both?
- How is running different from walking?
- Why do sprinters use starting blocks?
- What role do your arms play in walking and running?

The following activities are designed to answer these questions and probably generate new ones.

Question 1: *How fast is the runner going?*

Introduction

One of the most basic characteristics of motion is how fast it is occurring. For running involves measuring a distance traveled and dividing it by a time elapsed for the travel. Mathematically, this is represented by the equation: $s = d / t$ where s is the speed, d is the distance, and t is the time elapsed. In the metric system d is in meters, t is in seconds, and, consequently, speed is in meters per second or m/s. In the commonly used English system, d can be measured in feet, miles, or any of several other length units. Time can be expressed in seconds or minutes or even hours. Therefore the speed has units of feet per second (ft/s) or miles per hour (mph) among others.

Equipment Needed

1. Video camera
2. Video Cassette Player with single frame advance
3. Gymnasium with one wall marked off for distance
4. Brightly colored, wide tape to mark off distances
5. Whistle
6. Yardstick or meter stick
7. Stopwatch
8. Markers

Set Up

1. Position camera far enough away from wall so that the entire wall and the distance markers are clearly visible without changing camera angle.
2. Place marks on wall at equal intervals (like one foot) so that they easily visible through the camera.
3. Mark start and finish lines.

Procedure

1. Measure the total distance of the race from start to finish lines.
2. Have one student prepare to blow the whistle one short blast to start the race.
3. Have one student positioned at the finish line to time the race from whistle to finish line.
4. Have several students, one at a time, run the race.
5. Be sure the timer and whistle blower do not obscure a clear view of the runner against the marked wall as seen through the camera.

Analysis: Part I

Record for each runner the times measured for the race:

Table 1:

Runner # Time Distance Speed

1
2
3
4
5

Since speed equals distance divided by time, you can now simply take the total distance of the race and divide by each runners' time to determine their overall speed. This speed should be calculated for Table 1.

Part II

A more in-depth examination of the race can be made using the video tape of each runner's race. Since you know how much time elapses between frames (the frame interval, usually 1/30 sec), you can use a transparency taped to the monitor to mark the runners' progress from frame to frame and then determine the speed of the runner during increments of the race.

Be sure to mark the distance markers on the transparency using a different color marker. Use this procedure to fill in Table 2 below:

Table 2:

Frame # Position Time Elapsed (= #frames x frame interval)

For the total speed you take the total distance and divide by the total elapsed time. To look at incremental times you can figure the speed for various frame sets. For example, looking at the first few frames and comparing that speed to the average speed for the entire race should be interesting. If you wanted to figure the speed for the first ten frames you would use the equation:

$s = (\text{position at frame 10}) / (\text{time elapsed through frame 10})$ Do this for several intervals.

Continuance

1. Examine in more depth the way speed changes throughout the race. Introduce the concept of acceleration. Break down the race into component parts. What did you discover?
2. What do you think happens to speed as the race gets longer?
3. How could you design an experiment to examine a longer race?

Question 2: *Do short distance runners go as fast as long distance*

runners?

Introduction

As you probably implied from Question 1, average race speed is not equal to all of the interval speeds for any race. In all races, you must accelerate from a zero speed start. The question is how long can you maintain your highest velocity? Can you run at highest speed for 100 meters, 200, 400? To try to answer this question we can look at data in the form of old Olympic track statistics:

Distance (m) Time (seconds)

100 9.90

200 19.75

400 43.50

800 103.45

1500 212.53

5000 785.59

10000 1641.49

Equipment Needed

1. Calculator
2. Pens
3. Graph paper

Procedure

1. Using the formula $s = d / t$, calculate the average speed for each race. Fill in the table below.

Race Distance Average Speed (m/s)

100

200

400

800

1500

5000

10000

2. Graph this data to produce a running performance curve.

Questions/ Discussion

1. At what point is average speed maximized?
2. Why might a shorter race have a lower average speed than a longer race?
3. What accounts for the decline in average speed as the race lengthens?

Question 3: *Why do some people run sprints and some distance but rarely both?*

Introduction

You now know that all races are not created equal, but can we account for individual characteristics which produce great sprinters and great marathon runners? Some answers are suggested by looking at the physiology of athletic performance.

Equipment Needed

1. Internet access (optional)
2. Books on athletic performance and kinesiology

Procedure

Have students read articles on running and prepare a research paper on the needs of long and short distance runners. Responses should include discussion of slow and fast twitch muscle fibers, aerobic and anaerobic respiration, acceleration ability off starting blocks, strategy questions, and stimulus response time to starting guns.

Question 4: *How is running different from walking?*

Introduction

What criteria make a walk different from a run? Can be differences be defined easily? Careful examination of both gaits at slow motion should help.

Equipment Needed

1. Video camera
2. VCP with single frame advance
3. Transparencies
4. Markers

Procedure

1. Set up video camera to record a walk and a run over a set distance. (Using the same set up as in question 1 is convenient.)
2. Videotape a student walking naturally down the line; start to finish.
3. Videotape the same student running from start to finish.

Analysis: Walking

1. Examine the video of walking frame by frame. Use a transparency over the monitor to mark the positions of the right and left feet (in different colors) during the walk.
2. Be sure to indicate the distance markers on the wall in a third color on the transparency.
3. Using the video and the transparency answer the following questions:
 - a. Were both feet ever off the ground at the same time?
 - b. What was the average stride length ? (Stride length is define as the distance covered between foot falls.)
 - c. Using the frame interval time calculate the stride time.
 - d. What other performance variables did you observe?

Analysis: Running

Repeat the analysis for the runner. Answer these questions:

1. How does walking compare to running in terms of foot position, stride length, and stride time?
2. Can you now define the difference between walking and running?
3. Most scientists agree that there are three phases to walking. Can you suggest what these are?

Question 5: *Why do sprinters use starting blocks?*

Introduction

You've probably already guessed that for sprints the race is often won or lost at the gun. The reason is that the initial acceleration occupies a large proportion of the total time of a short race. Great runners can accelerate to 90% of their maximum speed in about 2 seconds and 99% of maximum in 4 seconds. How do they do it? Part of the answer lies in the starting blocks used for short races. To prove this you'll need to perform the following activity.

Equipment Needed

1. Track of at least 100 meters
2. Starting blocks
3. Stopwatch
4. Whistle

Procedure

1. Set up a 100 meter race with blocks.
2. Time the race from whistle start to finish.
3. Repeat these steps without using the blocks.
4. Fill out the table below.

Distance Time Speed ($=d/t$)

With blocks

Without blocks

5. Repeat for several different students.

Analysis/ Questions

1. Did starting from blocks enhance the average speed attained?
 2. Brainstorm why and how blocks might help with the initial acceleration.*
- * Teachers: Most experts agree that starting blocks help position the legs in a way which gives maximum muscle efficiency to the push off. They also provide better traction and ground contact which assures the maximum ground force reaction.

Question 6: *What role do your arms play in running?*

Introduction

At this point you have seen several people running and walking in slow motion. You should have noticed that their arms participated in this coordinated motion. Look at the video tapes again and try to describe the coordination in terms of left and right, forward and back. For example, as the right leg swings forward where is the left arm. Also, in what posture do we hold our arms in walking versus running? Try this experiment.

Equipment Needed

1. Video camera
2. VCR with single frame advance
3. Masking tape

Procedure

1. Set up a sin Question 1.
2. Videotape a student walking start to finish.
3. Now tape the student's arms to their sides so they cannot swing them.
4. Videotape the student walking start to finish again.
5. Repeat this procedure for running.

Analysis

Answer the following questions by looking at the tape and interviewing the subject

1. Is a coordinated arm movement associated with walking? running?
2. Is the person's gait different if the arms cannot be used?
3. How does it feel to have the arms pinned while walking? Running?
4. Describe how the arm movement/ posture differs between walking and running.

Question 7: *How can you throw a shot put for maximum distance?*

Introduction

Throwing a heavy spherical object has been a part of the Olympic Games since the modern Olympics began in 1896. Both men and women participate and they actually push the object (the shot put) rather than throw it. They must not take a running start, but they can take wind up motions as long as they are confined to a 7 ft. circular launch area. The shot put must also land within a 40° sector. The weight of the shot put varies from 16 pounds for men to 8.83 pounds for women but both are really difficult to launch from the shoulder and “put” any real distance. Here's your chance to try it!

Equipment Needed

1. Shot puts
2. Experienced shot putter or video disc “Physics of Sports” from Videodiscovery
3. Video camcorder
4. Tape measure

Procedure

1. Study the method used to launch the shot put by using the expert or the video disc.
2. Mark off a circular area outside to throw from and rough out the 40° sector in front of the circle.
3. Video tape students attempting to put the shot.
4. Record in the following table the average of three attempts from each person in your group:

Table 1:

Name	Attempt 1	Attempt 2	Attempt 3	Average
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Analysis/ Questions

1. What kind of prelaunch routine results in better distance?
2. Why would taller putters have longer throws on average?

Question 8: *What is the trajectory of a shot put?*

Introduction

Like all “thrown” objects a shot put is acted on by the velocity that is imparted to it by the putter and by gravity. The velocity of the “put” tends to move the shot forward while gravity pulls it down to the ground. Let’s analyze the motion using our video camera clips.

Equipment Needed

1. Video clips of question 7 throws

Procedure

1. Place a transparency over the monitor.
2. Advance the clips of a shot put throw frame by frame and mark the position of the shot put in each frame.
3. Use the analysis tool, VideoPoint®, to determine the equation of the curve.

Analysis/ Questions

1. What kind of curve is made by the falling shot put?

Question 9: *How can you throw a discus for maximum distance?*

Introduction

The discus throw has been a popular event since the first Olympic games in 708 BC. Originally winning the discus was its own reward because the winner got to keep the discus which was valuable because it was a solid copper disc. Now the discus throw is rewarded with a medal like all the other events. Disci are quite heavy and hard to throw accurately so great care should be taken when doing this activity.

Equipment Needed

1. Discus
2. Experienced thrower
3. Video camcorder
4. Tape measure

Procedure

1. Study the method used to throw the discus.
2. Mark off a circular area 8 feet in radius outside to throw from and rough out the 40° sector in front of the circle.
3. Video tape students attempting to throw the discus. Remember the other students should be paying attention and be behind the thrower since release and trajectory are unpredictable especially for novice throwers.
4. Record in the following table the average of three attempts from each person in your group:

Table 1:

Name	Attempt 1	Attempt 2	Attempt 3	Average
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